LUBRICATION

A Technical Publication Devoted to the Selection and Use of Lubricants

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High Temperature Lubrication

Factors Which Must Be Considered When Selecting Lubricants For Such Service

THE operation of industrial machinery requires consideration of certain basic factors wherever the matter of lubrication is involved. Pressure, speed and temperature are, in general of outstanding importance, for upon these should be based the selection of lubricants. In other words, the physical characteristics of any lubricant should be such that it will be able to develop the maximum of lubrication per unit of volume, under the prevailing pressure, speed and temperature of operation.

In this connection the matter of high temperature is worthy of special consideration. In all probability high temperature conditions will usually impose a greater requirement upon any lubricant than any other phase of operation.

The very fact that friction must occur between any two solid surfaces in motion with respect to one another, implies the presence of heat, for friction cannot occur without the development of a certain amount of heat. It is the function of lubrication to eliminate the occurrence of solid or metallic friction supplementing this with fluid friction which will normally be of far less intensity.

While the result of effective lubrication will be primarily a reduction in the amount of power or energy necessary to move the working elements with respect to each other, frictional heat will also be markedly reduced. This will, in turn, lead to more nearly perfect lubrication, for it will enable the lubricant to perform its intended functions more effectively by virtue of the maintenance of a lubricating film of approximately the requisite viscosity or body.

THE IMPORTANCE OF VISCOSITY

Viscosity varies inversely with temperature. That is, the higher the latter, the more fluid will the average lubricant become. Under controllable conditions this is an asset, for it may permit of the one lubricant being used to serve a number of points of varying external temperature, provided the size of the wearing elements and the pressure exerted are taken into account when the lubricant is originally selected.

What "Operating Viscosity" Means

Where there is possibility of temperatures varying, however, the "operating viscosity," or the body of the lubricant under actual working conditions within bearing clearances, for example, may be such as to preclude effective lubrication to a marked degree. If too heavy it will impose more or less drag, resulting not only in added power consumption but also in higher bearing temperatures due to internal friction. On the other hand, if this viscosity is too low, solid or metallic friction may occur, also to the detriment of the power bill, but more especially, will the bearing surfaces probably suffer from increased wear.

In consequence, there is a direct tie-up between power consumption, friction and temperature. Therefore, a discussion of high temperature lubrication, with a study of those characteristics of lubricants which will influ-

ence their selection, is of decided interest to all who must consider their operating and maintenance expense. This means progressive industry as a whole.

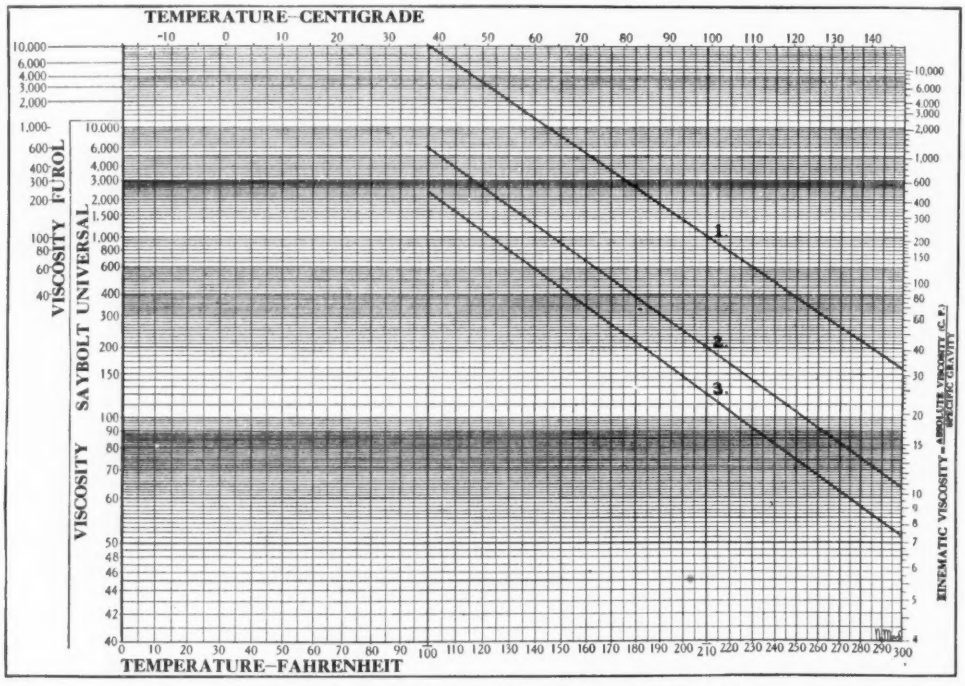
How Defined

Inasmuch as "operating viscosity" plays so important a part in this matter of high temperature lubrication, a detailed knowledge of viscosity in general will be advisable. Just

Method of Test

Viscosity is commonly measured by taking the time required for a certain quantity of the liquid in question to flow through an orifice of standard size under standard temperature conditions. The Saybolt universal viscosimeter has been adopted for this purpose by the American Society for Testing Materials.

In the oil industry it constitutes the measurement of the number of seconds required for


TEMPERATURE—CENTIGRADE
-10 0 10 20 30 40 50 60 70 80 90 100 110 120 130 140
VISCOSITY FUROL
VISCOSITY SAYBOLT UNIVERSAL
KINEMATIC VISCOSITY—ABSOLUTE VISCOSITY (C.P.)
SPECIFIC GRAVITY
1
2
3
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200 210 220 230 240 250 260 270 280 290 300
TEMPERATURE—FAHRENHEIT

[VISCOSITY—TEMPERATURE CHART]

©THE TEXAS COMPANY PETROLEUM AND ITS PRODUCTS

Fig. 1—The above chart shows the viscosity-temperature curves for three representative mineral lubricants adaptable to moderately high temperature service. The points of observed viscosity are 100° and 210° Fahr. in each case.

As an example of how to use this chart in the determination of the approximate "operating viscosity" of, say oil "1" at 300° Fahr. note that the extension of this curve to 300° Fahr. on the horizontal scale intersects the 160 seconds Saybolt viscosity line on the vertical scale. In other words, a condition of bearing operation which would require an oil of from 150 to 180 seconds Saybolt viscosity at normal room temperatures could be adequately taken care of by oil "1" at an operating temperature of 300° Fahr.

what is meant by the statement that an oil should have a viscosity of, let us say, 500 seconds Saybolt at 100° F. will be vague to many. It is well, therefore, to mention that this means that at a uniform temperature of 100° F. it will take 60 cubic centimeters of the oil in question 500 seconds to flow through the orifice of the standard Saybolt viscosimeter.

Viscosity is, therefore, an indication of the relative fluidity of an oil at the temperature of test. In brief, it is that inherent property by virtue of which the flow of liquids is retarded. It is, therefore, possessed by all oils in varying degrees. In effect it is a measure of the resistance offered by the particles or molecules of a liquid in sliding past each other.

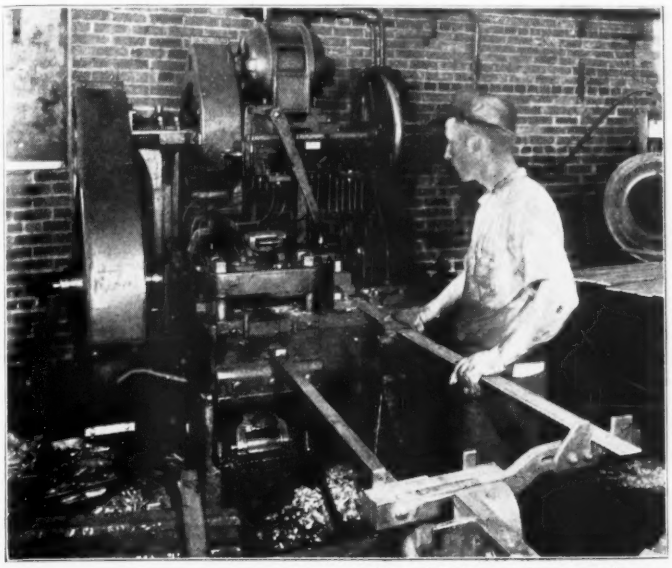
60 cu. cm. of oil to flow through the orifice at a definite or standard temperature.

For lighter products such as engine and machine oils, this latter is usually 100° F. For heavier oils, such as gear lubricants and steam cylinder oils, 210° F. is commonly used.

The Value of the Viscosity-Temperature Conversion Chart

As a rule it will be possible to readily ascertain the observed viscosity of any comparatively fluid lubricant at both 100° and 210° F. In consequence, with a suitable viscosity-temperature conversion chart available, a straight line can be drawn connecting these two points. The probable "operating vis-

cosity" at any temperature between this range can then be accurately determined; or, if above 210° F. it can be approximately decided upon by extending the aforesaid line until the operating temperature is reached. An actual case is worked out in connection with Fig. 1 to illustrate this point in detail.



Courtesy of McCord Radiator & Manufacturing Co.

Fig. 2—A spring eye forming machine for the manufacture of automobile springs. Note that this device is served by a mechanical force feed lubricator. This process involves the preliminary heating of spring steel to red hot; the ends are then formed as desired.

CARBON AN OBJECTIONABLE FEATURE

Wherever high temperature lubrication is involved there will very frequently be a possibility of development of carbonaceous deposits.

Of course, this will all depend upon the degree of heat present, the extent of refinement of the lubricant and the base of the crude from which it is made. From particular types of crude, for example, distillates can be made which will show an almost negligible amount of carbon. Where necessary to use residual oils such as cylinder stocks, on the other hand, the carbon residue content may run very high, depending of course, on the extent of refinement of the cylinder stock, and the amount used.

Dependent on Type of Service

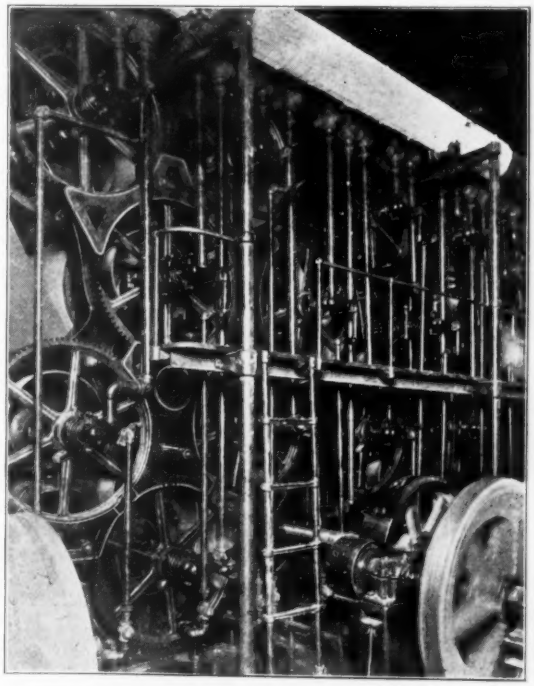
Whether or not this will be an ultimate detriment will naturally depend upon the use to which the lubricant is to be put. In an anti-friction bearing, for example, carbonaceous deposits due to abnormal vaporization of an oil under higher temperatures, might seriously impair effective rolling between the balls or rollers and their respective raceways.

On the other hand, a set of exposed gears adjacent to a Bessemer converter, would function effectively irrespective of the carbon content of the lubricant, provided that this latter possessed adequate body or viscosity to prevent actual metal-to-metal contact between the gear teeth, in the presence of the abnormal temperatures involved.

Effects on Internal Combustion Engine Operation

The internal combustion engine of the Diesel or semi-Diesel type is a most interesting case where lubrication of cylinders, especially, must be effected under comparatively high operating temperatures, and furthermore, where carbon residues may be of serious consequence.

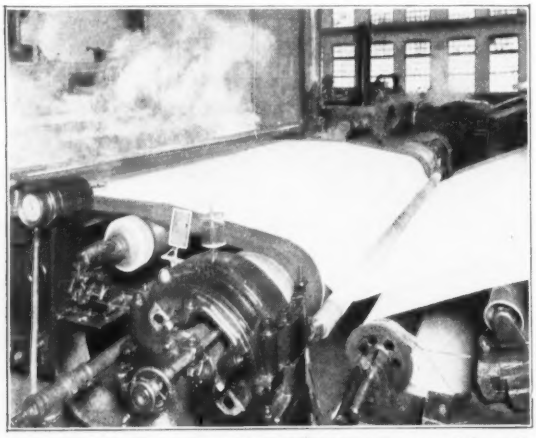
Broadly speaking, carbon can never be eliminated. It is an essential element in any petroleum fuel or lubricating oil, and, therefore, must pass through every engine. It is only a detriment, however, in the form of soot, or deposits of carbonaceous tarry matter. In chemical combination with hydrogen and oxygen it is a basic requirement, and a factor in the occurrence of combustion.



Courtesy of Beloit Iron Works

Fig. 3—The back side of stack of paper mill dryers. Note steam joints and exposed gearing which require careful attention to lubrication.

As long as complete combustion takes place, and cylinder lubricants are applied in the right amount, with no excess to perhaps be burned to carbon, there will be but little chance of valve trouble, loss of power or faulty piston-ring operation due to carbon deposits.



Courtesy of The Champion Coated Paper Co.

Fig. 4—View of a paper mill suction couch roll showing means for lubricating bearings.

Incomplete Combustion an Essential Cause of Carbon Deposits

Incomplete combustion in the oil engine for any reason, however, such as the delivery of an excess of fuel, imperfect or faulty atomization, impingement or spraying of the fuel on cylinder heads prior to combustion, the use of injection air at lower pressures than required, or the use of fuel oil of too high viscosity to permit of proper atomization under existing pressures, will all lead to carbon deposits.

As Is Also the Use of Too Much Lubricating Oil

The use of too much lubricating oil will also tend to promote accumulation of carbon especially where cylinder temperatures may be high and where there is possibility of the excess oil being burned to free carbon.

In the Two-Cycle Engine

In the two-cycle engine, wherever incomplete combustion occurs and too much cylinder lubricating oil is fed, the resultant carbon deposits will be particularly detrimental where they accumulate around, and tend to clog up the exhaust ports.

Incomplete combustion is the forerunner of such a condition, the resultant soot tending to dry up a normal lubricating film on the cylinder walls. The indications of this will be similar to the actions of the engine when overloaded, i.e., piston drag due to excessive friction causing smoke, knocking and laborious operation.

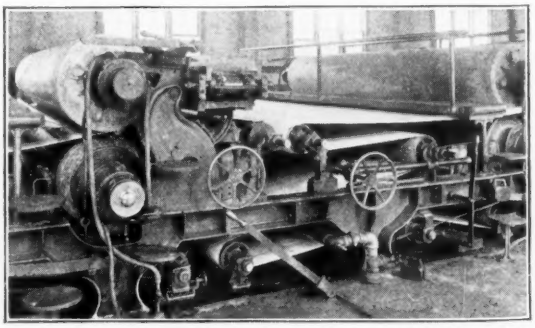
Heavy Fuel Oils Promote Carbon

Incomplete combustion will lead to abnormal carbon deposits within combustion chambers, etc., especially where heavier grades of bunker fuel or so-called boiler fuel oils are being fired. The continued use of heavier grades of fuel oil will entail the cleaning of combustion chambers at frequent intervals due to the carbonaceous deposits which will accumulate with the breaking down and combustion of such oils. Pistons, in turn, will also require regular cleaning where residual fuel oils are used, though not as frequently as the combustion chambers. To clean such surfaces effectively, a brass scraper will be found more suitable than emery or other abrasives, unless scoring has occurred.

Investigation, Therefore, Always Advisable

While but one or two instances have been cited, it is well to state that it will always be advisable to investigate in detail the carbon residue content of such lubricants as are to be used for lubrication of intricately designed mechanisms under high temperature operating conditions.

In this category would be included lubricants for electric motor bearings, certain types of steam turbines,—in fact, for service anywhere in the boiler or engine room, cement plant, paper trade, steel mill, textile or metallurgical industry, etc., where heat treating of products or the generation or application of steam may be involved.



Courtesy of Beloit Iron Works

Fig. 5—The press rolls in a paper mill showing water cooling hose for bearings. The use of cooling water will generally require attention to the non-emulsifying characteristics of the lubricants involved.

Methods of Test

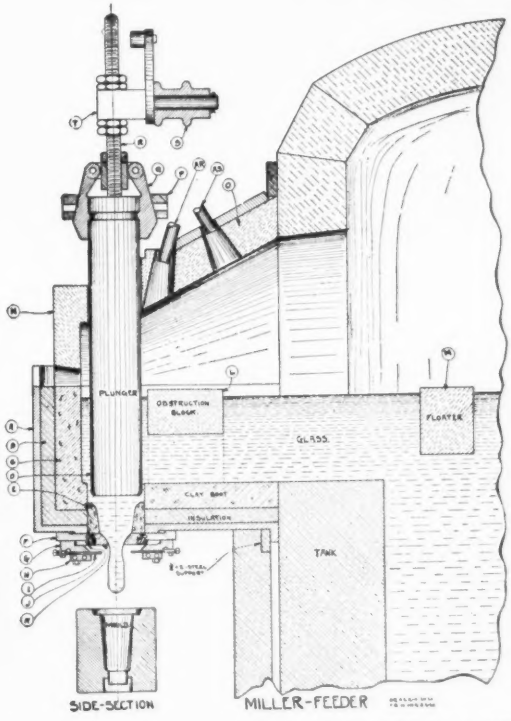
The determination of the carbon residue content of any proposed lubricant can be accurately made by the method adopted by the American Society for Testing Materials. In brief this involves the external heating of a

measured quantity of the oil within a suitable arrangement of crucibles until all vapors have been driven off—that is, until complete distillation has been accomplished. The residue within the innermost porcelain crucible will be the carbon residue content of the original sample of oil. By careful weighing it can be expressed on a percentage basis in relation to the oil under test.

A more relative means of determining the extent to which a lubricant will develop carbon residue involves the hot plate test, so familiar to the motorist. As a rule it is practicable as a qualitative test only.

This involves the use of a simple domestic type of electrically heated hot plate. By means of a suitable voltage-varying plug the ultimate temperature to which such a plate will be heated can be controlled. This is of especial value where lubricants to meet varying high temperature conditions are concerned.

The method of test is to bring such a plate



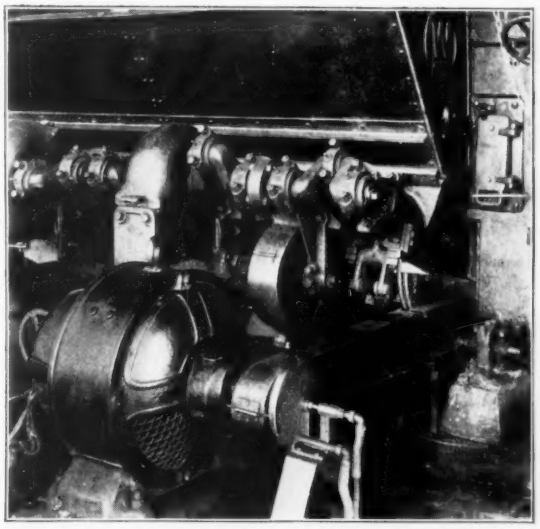
Courtesy of William J. Miller

Fig. 6—Sectional view of a type of automatic glass feeder, frequently used with pressware equipment. This machine requires from one to three drops of oil for each cut of molten glass, the lubricant being burned on each stroke of the plunger.

to the requisite temperature, and then deposit a drop of the proposed oil thereupon. The resultant smudge or carbon residue which will remain after vaporization of the lighter more volatile fractions which compose the lubricant, will indicate the relative degree to which such a product will probably develop carbonaceous deposits in actual service.

FLASH AND FIRE POINTS

It is also of importance to study the flash and fire points of lubricants where certain



Courtesy of Westinghouse Electric & Mfg. Co.

Fig. 7—The operating mechanism of an automatic stoker showing grease lubricated bearings and other parts exposed to radiated heat.

phases of exposed high temperature lubrication are involved; that is, where lubricants must be more or less directly exposed to flame, steam or electric heating mediums. Instances of this would involve the lubrication of open-hearth charging equipment in the steel industry, the lubrication of steam engines functioning on superheated steam, or the lubrication of automatic bake oven equipment in the baking industry.

Exposure of lubricants to direct heat involves the possibility of abnormal vaporization of the more volatile constituents, to result in accumulations of non-lubricating carbon residues. Continued exposure of these latter to high heats will cause coking of such residues, with subsequent clogging of oil grooves or other vital parts of the lubricating systems, etc.

It is, therefore, essential to make a careful study of such conditions with a view to selecting lubricants which will be capable of resisting these effects of high temperature as far as possible.

In other words, we are concerned with the flash and fire points. So a word as to just what these tests involve, will be of interest.

Method of Test

When the temperature of a petroleum product is gradually raised, a point will be reached where enough surface vapor is devel-

oped to ignite for a moment upon the application of a flame. The temperature of the oil at the moment of flash is regarded as the flash point of the product under test.

This test for flash point is arbitrary in that it depends upon the type of apparatus used, i.e., whether this latter employs an open or closed cup. In the United States the open cup prevails, the closed cup device being more largely confined to foreign usage.

Continue Raising Temperature for Fire Point

After having raised the temperature of the lubricant to the flash point temperature, heating can be continued in the same gradual manner until actual ignition takes place when the test flame is applied. When ignition continues for a period of at least 5 seconds the temperature of the oil at the time should be noted as the fire point.

Freedom from Draft Essential

Both flash and fire point tests should be made in a room or compartment which is free from air drafts. In fact the observer should even avoid breathing directly over the apparatus inasmuch as this might materially affect ignition of the vapors. To make the flash more readily discernible, the room should be darkened wherever possible.

Value as a Guide to Lubricating Ability

As a guide to the lubricating ability of any oil, flash and fire point readings are of value only as indicators of the relative initial volatility. They should not be regarded as definite temperatures at which boiling takes place, or at which the products may pass completely over to the vapor stage.

Relation to Viscosity

Higher flash and fire point oils will in general be of higher viscosity if of similar composition from a hydro-carbon viewpoint. This, however, lines up with the general requirements of high temperature lubrication as brought out in the discussion of viscosity.

Some Typical High Temperature Conditions

In connection with a discussion of high temperature lubrication, it will be well to study certain specific cases in industry where this may involve a decided problem. In fact an insight into conditions which must be counteracted in the steel mill, the modern bakery, the handling of materials in heat treating plants, the dyeing and finishing of textiles or the manufacture of glass, will aid materially in illustrating the method of attack and the means whereby effective lubrication is maintained.

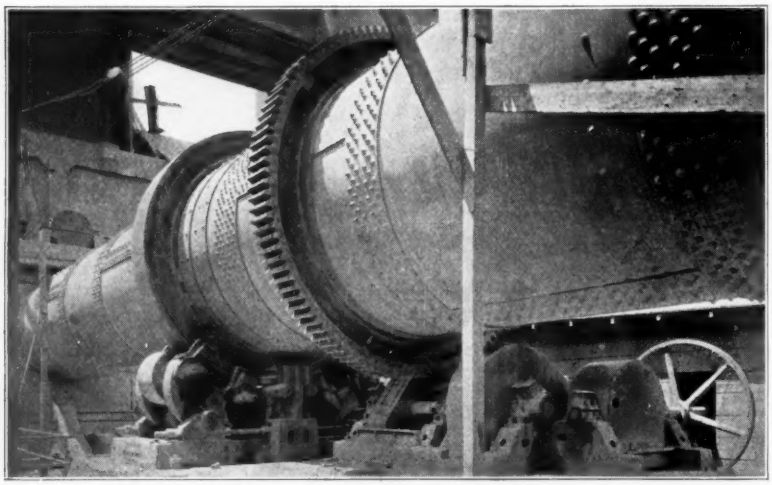


Fig. 8—The gears of a modern cement kiln also require careful attention to lubrication. Considerable radiated heat from within the kiln, coupled with high tooth pressures impose a decided load on the lubricant, high viscosity and adhesiveness are therefore essential characteristics of any lubricant for such service.

IN THE STEEL MILL

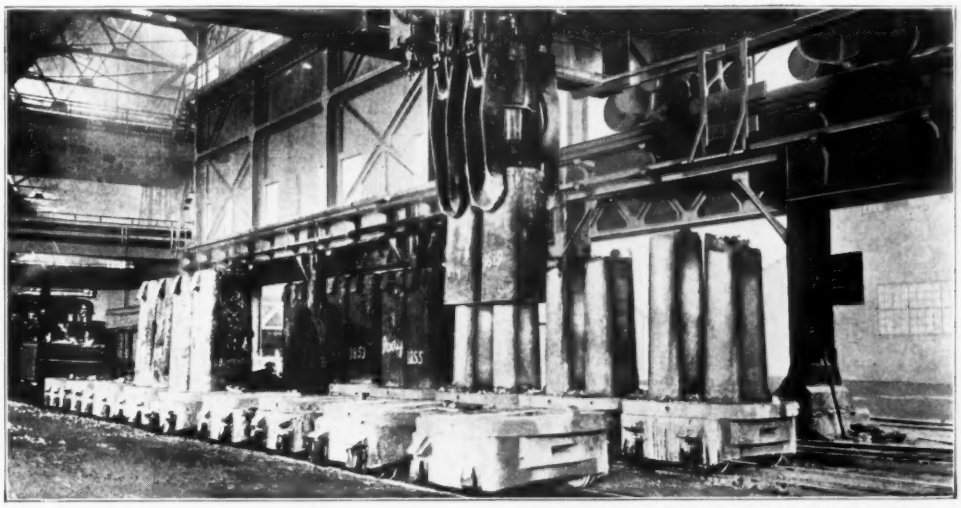
While the iron and steel industry will not involve high temperature lubrication as a whole, it is perhaps the outstanding example of the refinement and working of materials by means of direct heat, and the necessity for lubrication in the face of such conditions.

For example, iron ore as received from the mine is reduced to pig iron in the blast furnace. Pig iron is in turn converted into steel in the Bessemer converter or open hearth. From these latter, steel in molten condition is cast into ingots for subsequent rolling into billets, plates or shapes, etc., according to requirements.

The entire process of refining iron and treating steel, therefore, involves heat, either in the form of direct heat from combustion of coke, producer gas or fuel oil, or as radiated heat from steel in the course of rolling.

Gears, Pinions and Roll Necks

As a typical example, let us consider the gears, pinions and roll necks in the rolling mill. a most exacting requirement upon both the roll neck and gear lubricants. These must, therefore, be compounded products, inasmuch



Courtesy of The Youngstown Sheet & Tube Company

Fig. 9—Stripping ingots after solidification of steel in ingot moulds imposes a severe lubricating load upon ingot car wheel bearings and stripping crane wearing elements due to the effects of radiated heat.

The pinions adjacent to the roll necks in such mills are frequently enclosed in an oil-tight casing, in which event they are run in a bath of specially prepared gear compound of high adhesive characteristics, having a viscosity of about 2000 seconds Saybolt at 210° F.

On the other hand, in some installations these pinions may be only covered with shields which are not oil tight. Where this is done there is often no bottom to the gear case, therefore, bath lubrication is out of the question. Hence the lubricant must be able to stick tenaciously to the pinions and maintain a sufficiently protective film, over the periods which intervene between its application. A viscosity of about 5000 seconds Saybolt at 210° F. is frequently necessary in order that the resultant lubricating film will be able to withstand the intense heat which is radiated from the ingots or billets, and the terrific pounding and hammering which occurs, especially whenever the mill is reversed.

Not only in the blooming mill but on all other rolls except in the plate and sheet mills, is it found necessary to run water constantly over the rolls and roll necks for the dual purpose of cooling and blowing off scale which may be formed as the ingots, bars or billets are broken down. Some mills, in addition, blow steam directly onto the ingot during its first pass through the rolls in order to more effectively remove the scale.

Such conditions coupled with the extreme heat which is constantly encountered, impose as straight mineral lubricants will not withstand the continued washing action of hot water.

The usual procedure is to compound gear lubricants with definite percentages of certain substances which will give the final products the desired adhesive properties.

Rolling mill gearing, however, which does not come in contact with water can readily be lubricated with a straight mineral gear lubricant of a viscosity ranging from 2000 to 5000 seconds Saybolt according to temperature conditions and the manner of lubrication.

Bevel Gears

Another instance of severe service occurs with the bevel gears which drive the table rollers nearest to any type of rolling mill. Frequently these operate exposed. They are therefore subject to water conditions, flying scale and the heat which radiates from the hot metal in its course through the plant.

Application of Gear Lubricants

Here the gear lubricant is difficult to apply in the first place, and, furthermore, after it has been applied there is every obstacle put in the way of its functioning effectively. Centrifugal force will tend to throw it off, especially where it has suffered any extensive reduction in viscosity, due to over-heating. The washing action of the water which splashes over such gears is also a detriment.

In addition, excessive contamination by solid foreign matter can hardly be avoided, unless precaution is taken to effectively guard

Courtesy of The Youngstown Sheet & Tube Company

Fig. 10—An ingot buggy ready to carry a red-hot ingot of steel to the blooming mill. Wheel bearings are of course subjected to high temperatures, necessitating a lubricant of high plasticity and adhesiveness.

such gears. Ultimate protection can only be attained, therefore, by frequent applications of a lubricant which has been so refined as to withstand these detrimental conditions.

Usually the same product as used for the blooming mill gears must be employed; having a viscosity of from 1000 to 2000 seconds Saybolt at 210° F., according to weather and temperature conditions involved. It should be applied by pouring onto the teeth at the point of mesh while the gears are running inward. The frequency of application will of course depend upon the amount of steel rolled through the mill and the intensity of operation. In general, over-lubrication leads but to waste, for a uniform film which covers the entire wearing surfaces is all that is necessary for their adequate protection. The application of any excess lubricant will simply mean that it will be squeezed out and probably thrown from the teeth in a short time.

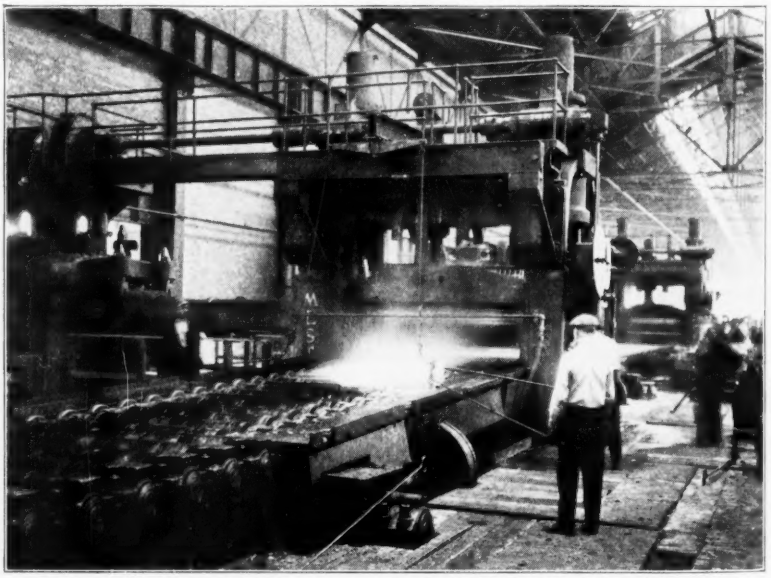
Salt Must Also Be Counteracted

Plate mills present still another detrimental condition due to the quantities of salt which are thrown on the plates during the process of rolling. Furthermore, the red hot plates pass directly over the bearings and gears of the table rollers. The purpose of salting is to remove the scale. Oftentimes, water is also sprayed on the rolls.

These factors, coupled with flying scale and dust which is driven with considerable force when the hot gases explode, tend to destroy any lubricant used on the roll necks, table roller gearing and other gears. Types of mineral gear lubricants as specified above have been found to withstand these detrimental elements quite satisfactorily provided they are applied at frequent intervals in sufficient quantities.

The Roll Neck Problem

Roll necks must be lubricated with a specially compounded roll neck grease that will not carbonize nor wash off when in contact with the water which is so often run over them to keep them cool. Lubricants used on such roll necks are termed cold neck greases. In general, they are tallow-mineral oil compounds, oftentimes being so prepared as to emulsify on contact with water.



Courtesy of The Youngstown Sheet & Tube Company

Fig. 11—In the steel plate mill, salt, heat and steam all ally to impair lubrication. Here a plate is shown in passage through the mill. Note the exposed journal ends on the table rolls.

Frequently, however, water is not used or

even where it is, the necks may run so hot as to melt down a cold neck grease. In such cases, a hot neck grease of high melting point must be substituted even though added friction and wear may be developed.

The residual fraction obtained by distillation of certain napthenic base crudes has also proven to be especially adaptable to such service. It has a high adhesive characteristic, is resistant to abnormal fluidity in the presence of heat, and is capable of refinement up to a viscosity of approximately 5000 seconds at 210° F.

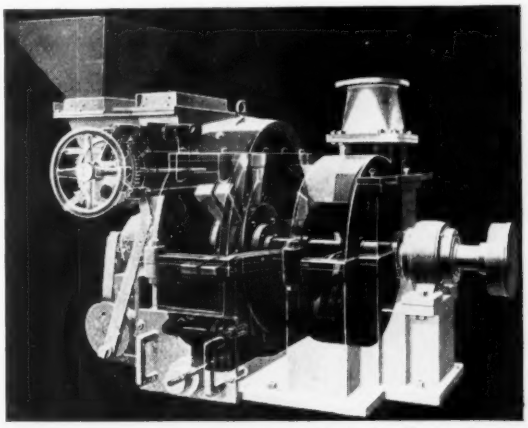
Selection of Suitable Lubricants

It is so impossible for the industry to effectively insulate surroundings as a whole against prevailing heat conditions, that as a result, much of the mechanical equipment will function at more or less high operating temperatures as outlined above.

If these are taken into account, however, when lubricants are being selected, there should usually be no subsequent difficulty. But if oils and greases are bought on a price basis alone, inferior or unsuitable products will often be furnished to the plant operatives.

These latter, where for example, lubrication of the turning gears of a Bessemer converter or the mechanisms of an open hearth charging crane are involved, will be prone to regard this as a fruitless procedure with the idea that any lubricant will "burn up"—so why be any too careful in using it.

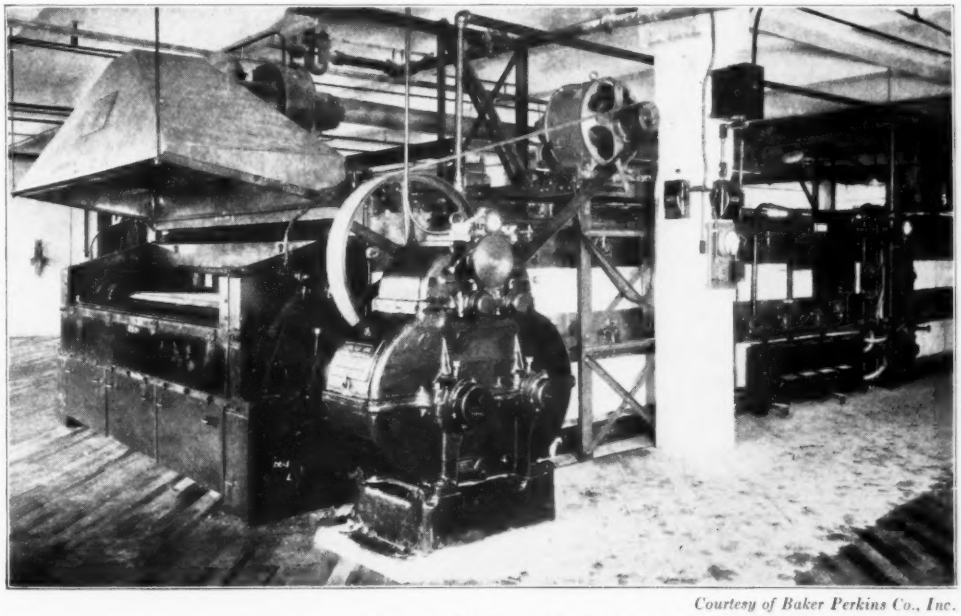
This is an erroneous impression in most cases; still and all, unsuitable lubricants may "burn up," at that. But properly refined products of adequate "operating viscosity" to meet pressure conditions, will usually serve the intended purpose quite satisfactorily.



Courtesy of Combustion Engineering Corp.

Fig. 13—Phantom view of a coal pulverizer. Frequently the working elements of such equipment will be exposed to considerable heat.

The progressive steel executive has realized these facts and today, it may well be said that industry as a whole can learn much in the way of effective lubrication under abnormal temperature conditions, by a study of modern steel mill methods. To exemplify these, Lubrication in the Steel Industry was discussed in detail in LUBRICATION about three years ago. The



Courtesy of Baker Perkins Co., Inc.

Fig. 12—View of the operating mechanisms of a modern baking oven. In certain ovens a particular problem of lubrication is involved due to subjection of the traveling chain links to the usual temperatures of baking.

principles, the equipment involved, and the recommendations stated in these articles still hold true.

THE BAKING OVEN

Baking is another industry wherein effective lubrication under comparatively high temperatures, will materially increase production and decrease upkeep and repair expense. Here, of course, we will be primarily involved with oven lubrication.

In the modern traveling oven lubrication is an important factor in the attaining of maximum efficiency. It can be readily appreciated that shutting down of such an oven would absolutely terminate production over the period of shut down.

Temperature and Rigidity Involved

The usual design and construction of the driving mechanism for the conveyor, and the component parts of this latter involves rigidity. Under normal room temperature conditions but little difficulty from a lubricating point of view should ever occur. The fact, however, that oven temperatures may run as high as 600° F. will require that lubricants for such parts as may be more or less exposed to such heat, must be carefully chosen from a viscosity and carbon residue angle.

Method of Heating

As generally constructed, heat is supplied to the modern traveling oven from furnaces located below the baking space, in order to keep the oven room as free from dust and dirt as possible. The principle of hot air or steam heating is used, suitable dampers being installed to regulate "top" and "bottom" heats as necessary.

In operation conveyor chain links, rollers, bushings and rods are subjected to most exacting service and frequently are expected to run for indefinite periods without requiring any extensive repair. This can be assured only by proper lubrication.

As stated, lubrication of certain parts will be quite a problem due to the prevailing heats. The average cup grease, or machine oil can usually not be relied upon, therefore, to function effectively, especially if their viscosity characteristics are comparatively low.

This has led to somewhat of the same attitude among certain operators, as mentioned in connection with the steel industry, i.e., that effective lubrication is practically hopeless, therefore, why pay any attention to it at all. The result, in some cases will be absolute neglect of such parts.

Selection of Lubricants

Judicious selection of lubricants, which will have the essential characteristics to insure service under higher temperatures, as discussed heretofore, will on the other hand, prove this argument to be erroneous, and will justify their usage by reducing repair and upkeep expense of such parts.

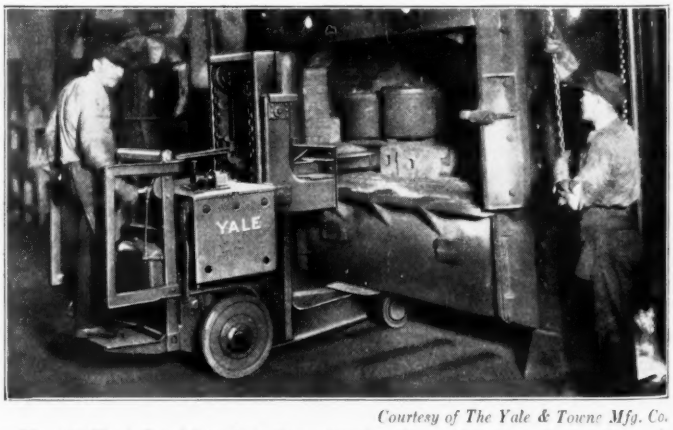
For example, a high melting point grease compounded from a high viscosity, low carbon content mineral cylinder oil should function effectively where grease lubrication is called for.

Where oil is required, if a heavy bodied, low carbon content straight mineral product is employed, the "operating viscosity" at the prevailing oven temperature will probably approximate that of a medium bodied machine oil. Adequate penetration to all clearance spaces should, therefore, result with the maintenance of a suitable lubricating film to prevent metal-to-metal contact and the development of the least amount of objectionable carbon residue.

STEAM HEATING—CYLINDER OILS—OIL SEPARATORS

Where exhaust steam is to be used in process heating, especially in the manufacture of certain products of a particularly perishable nature, the problem of lubrication may become more involved due to the vigilance which must be constantly observed to prevent "oil spots" or other contamination.

The dyeing and finishing of textiles will form an excellent illustration in this regard. In the dye-house and on certain types of shrinking or fulling equipment, wet treatment is necessary, the solutions being frequently heated by exhaust steam.



Courtesy of The Yale & Towne Mfg. Co.

Fig. 14—The industrial truck in the automotive plant. Charging a furnace by truck saves labor to a marked degree. Careful attention, however, must be given to lubrication of the wearing parts subjected to furnace heats.

As a general rule compounded cylinder oils will be extensively used in such plants due to the fact that saturated or wet steam will prevail. To therefore accomplish effective lubrication of steam engine cylinders an oil must be used which will contain a certain amount of animal fat in order to promote emulsification or lathering, and increase the adhesiveness of the lubricating film in the face of the washing-off action of the moisture.

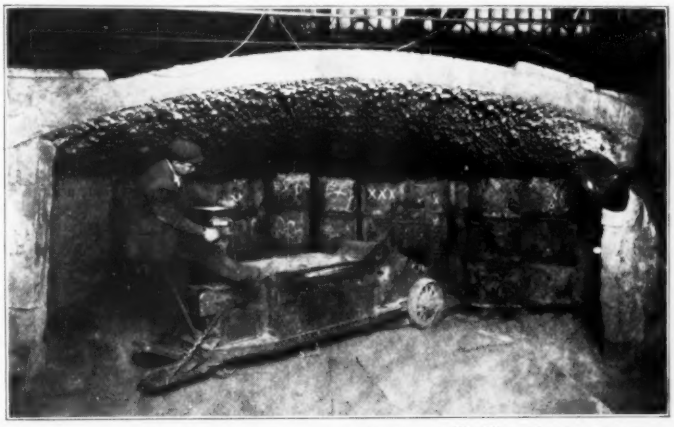
The Use of Exhaust Steam

In many plants, there will be sufficient heat available in the exhaust steam from such engines, to enable its usage as a process or hot water heating medium. Effective separation of lubricating or fatty constituents will, therefore, be necessary, prior to subsequent usage of such steam, otherwise there will be danger of these products spotting the materials under treatment in such a manner as to materially interfere with dyeing especially if this is to be done by the piece.

Essentially a dual problem of both high temperature lubrication and the matter of oil separation is involved. If this is attacked in a judicious manner the resultant steam should be capable of performing its function of process heating in a satisfactory manner.

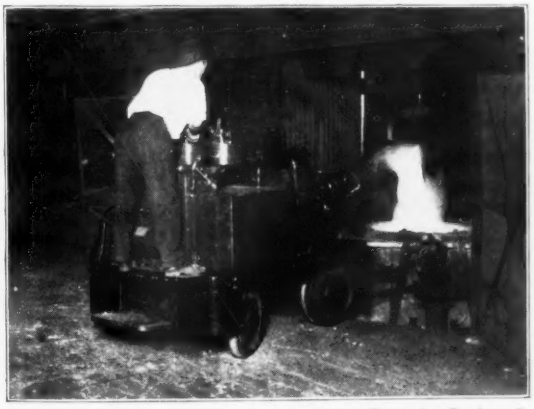
Selection of Cylinder Oils

In the first place steam cylinder oils should be selected after careful consideration of the prevailing moisture content of the steam. It is wasteful to use an oil containing, say eight percent of compound when five percent would serve the purpose. Furthermore, the greater the amount of compound or fatty matter in the original oil, the greater the percentage which may be carried over from the engines by the exhaust steam. Also, the greater the fatty oil content the more difficult will it be to effect subsequent separation to a sufficient extent to render exhaust steam suitable as a heating medium for textile wash waters or soaking solutions.



Courtesy of The Elwell-Parker Electric Co.

Fig. 16—The industrial truck is also admirably suited to service as a handler of foundry materials and for the placing of furnace pots.



Courtesy of The Baker-Raulang Co.

Fig. 15—Molten materials can also be handled by the industrial charging or ladle truck. Here again is involved the same problem of lubrication under comparatively high temperature conditions.

Under-Lubrication Never Advisable

It is for this reason that many engineers will be prone to under-lubricate or neglect the requirements of their engines. This is not necessary, however. If an oil is used which is refined and compounded to meet the steam pressure, temperature and moisture conditions, and if it is applied sparingly, in order to reduce the amount which may be carried over by the exhaust, the load on the separators will be reduced to a marked degree. In other words, the efficiency of the latter will be increased and the separated steam will be more completely purified and rendered less detrimental to certain fragile products such as silks.

VARIED TEMPERATURE CONDITIONS

Where equipment may be required to function but part of the time under abnormally high temperature conditions, the problem of lubrication may frequently develop certain complications. It can be appreciated that the lubricants used must be of such a nature as to be capable of meeting not only normal temperature requirements, but also such duty as may be the result of overheating.

Essentially the question of viscosity is involved. This brings up the matter of the viscosity chart once again, for this latter affords a most admirable means of checking up on the potential capabilities of any lubricating oil.

Further study of the previously mentioned example is therefore advised.

The Turbine as an Example

The lubrication of the reduction-geared steam turbine forms an excellent example of where it will be advantageous to use an oil having a steep viscosity curve. Here the oil must meet not only the intensive pressures which occur between the gear teeth, at very nearly room temperatures but also it must be able to withstand such reductions in viscosity as may occur at higher bearing temperatures—and still enable effective bearing lubrication.

It is for this reason that napthenic base oils of a viscosity of 300 to 500 seconds Saybolt at 100° F. have been found to be so applicable to such service.

The Industrial Truck

Another instance which will illustrate the necessity for certain lubricants to be able to function effectively under varied temperature conditions, is in the operation of materials handling equipment such as the industrial truck. In the heat treating of metals, for example, such trucks will frequently be alternately exposed to furnace heats in the charging or removing of materials—and to atmospheric temperatures in the transportation of their loads to and from the storage building or yard.

It can be appreciated that any oils used must not vaporize abnormally or become too far reduced in body or viscosity under higher temperatures, nor too sluggish under low temperature conditions. Greases, in turn, must not separate, nor should their oil content fail to conform with the requirements mentioned above.

The cylinder stock grease is a product which is admirably suited to varied temperature conditions. By proper refining of the oil content it is possible to render it not only capable of meeting normal cold conditions, i.e., down to approximately 20° F., but also the carbonizing and vaporizing effects of furnace heats such as might result from operation adjacent to the steel mill open hearth, or the heat treating oven.

As a result, grease of this nature is quite extensively recommended for lubrication of industrial truck motor bearings, universal joints and even certain of the gears.

CONCLUSION

There is perhaps no more interesting field to the lubricating engineer than that which involves high temperatures. The dissimilarity of the problems which present themselves from time to time, the varied requirements which the lubricants must meet, and the wide range of operations which must be considered, all require a most intimate knowledge of the fundamentals of industrial engineering and petroleum technology.

But not alone is the lubricating engineer involved, although he may be the ultimate factor in the solution of many existing problems. Every engineer or operator who may have to deal with high operating temperatures on any of his equipment should study conditions and ascertain the desirable properties which should be possessed by lubricants in order to insure the most satisfactory lubrication.

The purpose of the foregoing article has been to emphasize the importance of these factors and give an insight into operating conditions where high temperatures prevail. It has been felt that discussion of typical instances will be of interest to all who may have to deal with the matter of high temperature lubrication. Thus, with a knowledge of the duty to which the lubricants will be subjected and an understanding of the characteristics of such products as are especially prepared to meet this service, as indicated on the opposite cover, the selection of the right lubricant should be materially simplified.

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